PB-242 815

PETENWELL FLOWAGE, JUNEAU, ADAMS, AND WOOD COUNTIES, WISCONSIN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Wisconsin Department of Natural Resources
Wisconsin National Guard

June 1975

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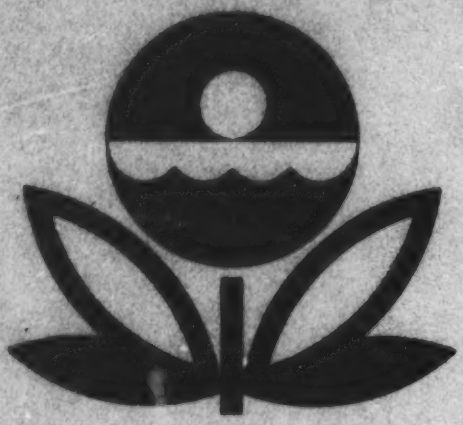

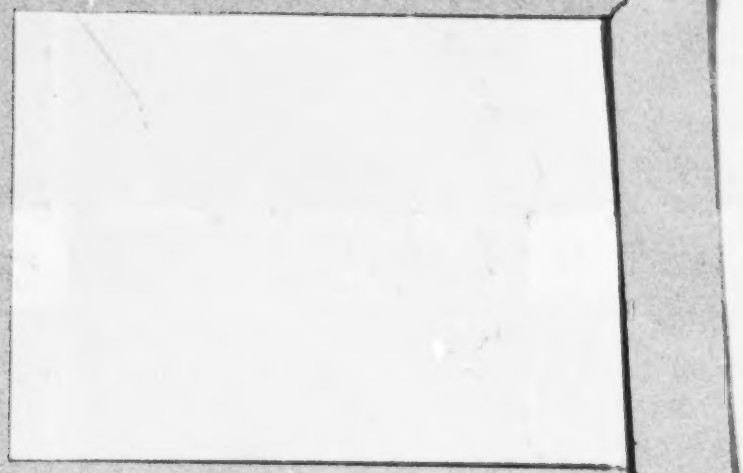

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TECHNICAL REPORT DATA
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1. REPORT NO.	2.	3. PB 242 815
4. TITLE AND SUBTITLE Report on Petenwell Flowage, Juneau, Adams, and Wood Counties, Wisconsin		5. REPORT DATE Prepared June, 1975 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 74
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1972 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

PRICES SUBJECT TO CHANGE

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited		23
	20. SECURITY CLASS *(This page)*	22. PRICE 3.25/2.25

Form 2220-1 (9-73)

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REPORT
ON
PETENWELL FLOWAGE
JUNEAU, ADAMS, AND WOOD COUNTIES
WISCONSIN

EPA REGION V

WORKING PAPER No. 74

WITH THE COOPERATION OF THE

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

AND THE

WISCONSIN NATIONAL GUARD

JUNE, 1975

CONTENTS

	Page
Foreword	ii
List of Wisconsin Study Lakes	iv, v
Lake and Drainage Area Map	vi
Sections	
I. Introduction	1
II. Conclusions	1
III. Reservoir Characteristics	3
IV. Lake Water Quality Summary	4
V. Literature Reviewed	9
VI. Appendix	10

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conducting the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

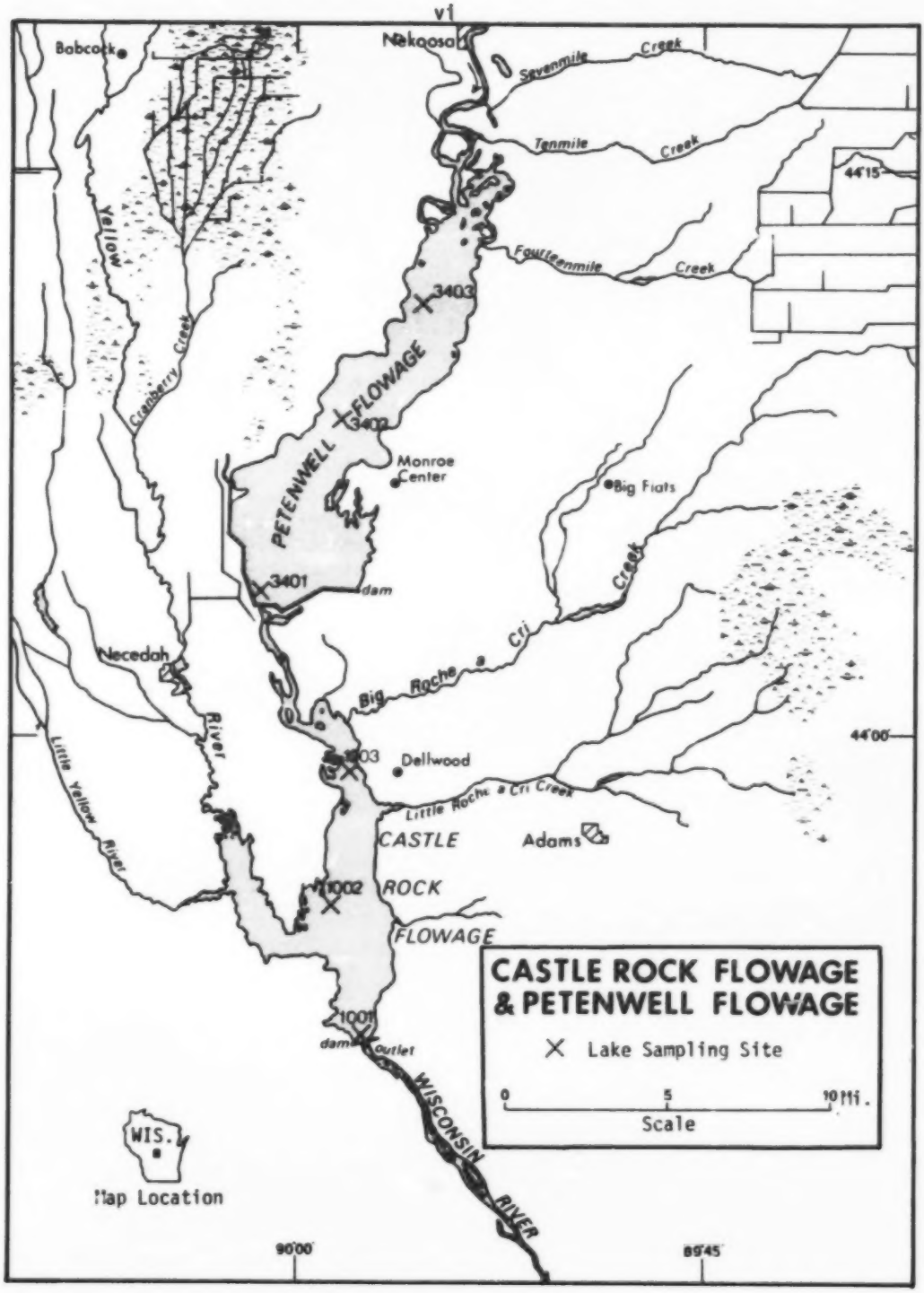
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano
Sinnissippi	Dodge

LAKE NAME	COUNTY
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


Babcock
Nekoosa
Sevenmile Creek
Tenmile Creek
Fourteenmile Creek
44°15'
Yellow
Cranberry Creek
3403
FLOWAGE
3402
PETENWELL
Monroe Center
Big Flats
3401
dam
Necedah
Big Roche a Cri Creek
River
Little Yellow River
3403
Dellwood
44°00'
Little Roche a Cri Creek
CASTLE
Adams
1002
ROCK
FLOWAGE
1001
dam
outlet
WISCONSIN RIVER
WIS.
Map Location
90°00'
89°45'
CASTLE ROCK FLOWAGE
& PETENWELL FLOWAGE
X Lake Sampling Site
0
5
10 Mi.
Scale

PETENWELL FLOWAGE

STORET NO. 5534

I. INTRODUCTION

Petenwell Flowage was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report only relates to the reservoir sampling data.

Petenwell Flowage was formed by impoundment of the Wisconsin River near Necedah by the Wisconsin River Power Company in 1949. Domestic, food-processing, and pulp and paper mill wastes are discharged to the Wisconsin River above the Flowage (McKersie, et al., 1970). Reportedly, there are seven pulp and paper mills in the 25 river-miles above Petenwell Flowage (Kluesener and Lee, 1973).

II. CONCLUSIONS

A. Trophic Condition:

Survey data and studies by others (Kluesener, 1968; Kluesener and Lee, 1973) indicate Petenwell Flowage is eutrophic. Of the 46 Wisconsin lakes sampled, 22 had less mean total phosphorus, 30 had less mean dissolved phosphorus, 33 had less mean inorganic nitrogen, 28 had less mean chlorophyll a, and 36 had greater mean Secchi disc transparency. Dissolved oxygen was depressed but not depleted in August, 1972. However, severe dissolved oxygen problems

occur in the Flowage (Schraufnagel, 1974), and partial winterkill conditions exist (Klick and Threinen, 1969).

Survey limnologists noted moderate to heavy algal blooms at sampling stations 2 and 3 in August and reported what appeared to be surface foam from pulp and paper mill discharges.

B. Rate-Limiting Nutrient:

The algal assay results indicate Petenwell Flowage was phosphorus limited at the time the sample was taken (11/08/72). However, the sampling data indicate nitrogen limitation in June and August.

Considering the results of his study, Kluesener (1968) thought it likely that the Flowage is light-limited due to absorption by color resulting from pulp and paper mill wastes as well as natural sources. While this probably was a factor during Survey sampling, the numbers of phytoplankton and the levels of chlorophyll a indicate light inhibition was not as important as during Kluesener's study.

III. RESERVOIR CHARACTERISTICS

A. Morphometry†:

1. Surface area: 23,040 acres.
2. Mean depth: 19.8 feet.
3. Maximum depth: 42 feet.
4. Volume: 456,000 acre-feet.
5. Mean hydraulic retention time: 47 days*.

B. Precipitation**:

1. Year of sampling: 42.7 inches.
2. Mean annual: 30.7 inches.

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† Ball, 1973.

* Based on mean Wisconsin River discharge of 4,906 cfs at Wisconsin Rapids (Anonymous, 1974).

** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Petenwell Flowage was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the reservoir and usually from two or more depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 38 feet at station 1, 27 feet at station 2, and 4 feet at station 3.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the reservoir essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/08/72)		
Temperature (Cent.)	5.1	5.7	5.7	5.8
Dissolved oxygen (mg/l)	8.6	9.0	9.0	10.3
Conductivity (μmhos)	120	136	135	150
pH (units)	7.0	7.0	7.0	7.1
Alkalinity (mg/l)	26	29	29	34
Total P (mg/l)	0.047	0.055	0.054	0.070
Dissolved P (mg/l)	0.021	0.026	0.025	0.031
NO_2 + NO_3 (mg/l)	0.250	0.267	0.260	0.300
Ammonia (mg/l)	0.110	0.120	0.120	0.140
		ALL VALUES		
Secchi disc (inches)	23	28	27	36

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/24/72	1. Melosira	2,206
	2. Dinobryon	814
	3. Cyclotella	615
	4. Anabaena	542
	5. Flagellates	452
	Other genera	1,465
	Total	6,094
08/18/72	1. Aphanocapsa	2,929
	2. Microcystis	434
	3. Nitzchia	180
	4. Anabaena	108
	5. Cryptomonas	108
	Other genera	653
	Total	4,412
11/08/72	1. Lyngbya	3,219
	2. Raphidiopsis	913
	3. Melosira	154
	4. Flagellates	81
	5. Cryptomonas	72
	Other genera	253
	Total	4,692

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/24/72	01	11.8
	02	9.2
	03	11.5
08/18/72	01	0.6
	02	1.0
	03	106.7
11/08/72	01	5.3
	02	5.0
	03	7.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.021	0.302	3.4
0.006 P	0.027	0.302	5.2
0.012 P	0.032	0.302	7.7
0.024 P	0.045	0.302	7.0
0.060 P	0.081	0.302	8.4
0.060 P + 10.0 N	0.081	10.302	32.8
10.0 N	0.021	10.302	2.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates the potential primary productivity of Petenwell Flowage was moderately high at the time the sample was taken (11/08/72). Also, the increased yields with increased levels of orthophosphorus show that the Flowage was

phosphorus limited at that time (note the lack of yield response when only nitrogen was added).

The reservoir data confirm phosphorus limitation in November (N/P ratio = 17/1) but indicate nitrogen limitation in June (N/P = 11/1) and August, 1972 (N/P = 6/1).

V. LITERATURE REVIEWED

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Schraufnagel, Francis H., 1974. Personal communication (review of preliminary report on Petenwell Flowage). WI Dept. Nat. Resources, Madison.

VI. Appendix

Appendix A

Physical and Chemical Data

STORET RETRIEVAL DATE 74/09/30

553401
44 03 42.0 090 01 12.0
PETENWELL FLOWAGE
55 WISCONSIN

11EPALES
3

2111202
0022 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/24	07 15	0000	17.0	7.6	30	143	6.51	39	0.160	0.420	0.090	0.066
	07 15	0020	18.0	7.9		140	6.52	30	0.150	0.410	0.083	0.071
72/08/18	12 10	0000			36	155	7.10	25	0.500	0.100	0.072	0.065
	12 10	0004	23.2	5.8		160	7.00	27	0.500	0.080	0.069	0.063
	12 10	0015	22.2	5.2		160	7.00	23	0.490	0.080	0.077	0.065
	12 10	0020	21.1	4.4		165	6.80	25	0.480	0.090	0.076	0.068
	12 10	0027	20.3	3.5		168	6.80	23	0.470	0.110	0.129	0.070
	12 10	0035	20.2	3.5		170	6.75	28	0.470	0.120	0.094	0.068
72/11/08	08 40	0000			23	145	7.10	31	0.260	0.110	0.052	0.025
	08 40	0004	5.7	9.0		140	7.00	26	0.250	0.110	0.047	0.029
	08 40	0015	5.7	9.2		140	7.00	27	0.260	0.120	0.050	0.025
	08 40	0022	5.7	9.0		140	7.00	26	0.260	0.120	0.048	0.027
	08 40	0030	5.7	9.0		140	7.00	28	0.260	0.120	0.051	0.029
	08 40	0038	5.7	9.0		150	7.00	29	0.250	0.110	0.054	0.031

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/24	02 15	0000	11.8J
72/08/18	12 10	0000	0.6J
72/11/08	08 40	0000	5.3J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

553402
44 08 30.0 089 59 00.0
PETENWELL FLOWAGE
55 WISCONSIN

11EPALES 2111202
4 0012 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/24	07 30	0000	17.8	7.6	27	125	6.56	35	0.190	0.400	0.062	0.052
	07 30	0010	18.0	6.8		125	6.50	35	0.180	0.380	0.078	0.054
72/08/18	13 50	0000			30	180	7.00	30	0.140	0.210	0.064	0.051
	13 50	0004	23.3	4.7		175	6.90	32	0.180	0.190	0.062	0.056
	13 50	0013	22.6	4.3		180	6.90	32	0.130	0.190	0.061	0.052
72/11/08	09 00	0000			24	135	7.10	34	0.280	0.130	0.054	0.025
	09 00	0004	5.7	8.6		135	7.10	34	0.280	0.130	0.053	0.027
	09 00	0015	5.8	8.9		135	7.10	32	0.260	0.120	0.054	0.025
	09 00	0020	5.8	8.7		135	7.00	32	0.260	0.110	0.056	0.024
	09 00	0027	5.8	8.6		135	7.00	30	0.250	0.110	0.054	0.025

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/24	07 30	0000	9.2J
72/08/18	13 50	0000	1.0J
72/11/08	09 00	0000	5.0J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

553403
44 11 12.0 089 55 37.0
PETENWELL FLOWAGE
55 WISCONSIN

11EPALES
3

2111202
0008 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/24	07 50	0000	18.0	7.1	27	180	6.71	42	0.080	0.530	0.108	0.088
72/08/18	13 20	0000			24	195	7.00	34	0.050	0.100	0.135	0.067
	13 20	0004	26.0	5.6		185	6.50	34	0.050	0.110	0.086	0.035
72/11/08	09 30	0000			30	120	7.10	26	0.300	0.140	0.070	0.023
	09 30	0004	5.1	10.3		120	7.10	27	0.300	0.130	0.069	0.021

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/24	07 50	0000	11.5J
72/08/18	13 20	0000	106.7J
72/11/08	09 30	0000	7.3J

J VALUE KNOWN TO BE IN ERROR